Claim rejections under 35 USC §112, second paragraph

Claims 2-7 and 19-21 stand rejected under 35 USC §112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention. According to the Office Action, "the term 'anaerobic' is vague and indefinite."

Applicants respectfully traverse.

As a basis for the rejection, the Office Action relies on 35 USC §112, second paragraph which states:

> The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

Applicants' specification concludes with claims, e.g., 2-7 and 19-21, which particularly point out and distinctly claim exemplary subject matter which the Applicants regard as their invention. For example, claims 2-4, 7, and 19-21 recite the claim feature "anaerobic conditions" and claims 5 and 6 recite the claim feature "anaerobic environment."

Applicants' specification clearly describes the meaning of "anaerobic conditions" and/or "anaerobic environment" as used in the present invention, in particular claims 2-7 and 19-21 respectively. For example, at pages 20-21 of Applicants' Application as originally filed, the specification states:

> The next stage of operation is the gas purging stage. In this stage, process chamber 14 is purged with a flow of one or more nonoxidizing gases in order to controllably establish and maintain an anaerobic processing environment with a controlled, reduced amount of oxygen. The ability to control the oxygen level during the curing process is important, because many dielectric precursors as well as the resultant dielectric films are susceptible to thermal oxidation at elevated temperatures in the presence of oxygen. For many dielectric materials, especially dielectric materials containing organic components, thermal oxidation becomes a risk even in ordinary air at temperatures in the range of from about 325°C to about 375°C, depending upon the particular material. Because dielectric precursors are generally cured at temperatures well above this temperature regime, the substrates bearing these materials are desirably maintained in an anaerobic environment so long as the substrates are hot enough for thermal oxidation to be an undue risk.

Thus, based on Applicants' specification, it is clear that an anaerobic environment or condition is maintained, e.g., so long as thermal oxidation is an undue risk. Applicants' specification also

describes that a suitable anaerobic environment or condition may vary depending on, e.g., dielectric material (e.g., organic or inorganic) and temperature (See, Applicants' specification at, e.g., line 16, page 20 to line 5, page 21).

Several non-limiting examples of typical "anaerobic" conditions and/or environment are provided in Applicants' specification as originally filed, e.g., from page 20, line 13, page 20 to line 5, page 21 as follows:

> Accordingly, when the dielectric material being used is organic, the oxygen content is desirably as low as possible. Taking practical considerations into account, the oxygen content during anaerobic processing is preferably up to 200 ppm, more preferably 1 to 200 ppm, most preferably 5 to 20 ppm.
> A somewhat higher oxygen level may be desired for other kinds of dielectric materials in order to help ensure that curing proceeds in a preferential direction. For example, inorganic dielectric precursors benefit from having oxygen present in order to help ensure that curing occurs with minimal side reactions. Accordingly, when the dielectric materials being used are inorganic or inorganic-organic, process chamber 14 is purged under conditions effective to establish an anaerobic processing environment containing 100 ppm to 2000 ppm, preferably about 200 ppm oxygen.

Other non-limiting examples of typical "anaerobic" conditions and/or environment are provided in Applicants' specification as originally filed, e.g., Example 1, lines 29-30, page34; Example 2, lines 31-32, page 36; and Example 4, lines 12-14, page 38.

Thus, the use of the term "anaerobic," as recited in Applicants' claims 2-7 and 19-21, particularly points out and distinctly claims exemplary subject matter which the Applicants regard as their invention.

Therefore, Applicants respectfully request the rejection of claims 2-7 and 19-21 under 35 USC §112, second paragraph be withdrawn.

Claim rejections under 35 USC 103

Claims 1-37 stand rejected under 35 USC 103(a) as being unpatentable over Yang et al. (6,042,994) in combination with Yoshioka et al. (5,968,691) further in combination with Boas et al. (6,215,106).

After merely citing the Yang, Yoshioka, and Boas references, the Office Action makes the following conclusory statement:

> *Yang et al., in combination with Yoshioka et al., further in view with Boas et al. teach forming a dielectric film on a plurality of substrates by coating a dielectric film on a substrate inside a coating chamber, prebaking the film, cooking the film and finally curing the film ....*

Applicants respectfully traverse the rejection.

Section 2143 of the MPEP states requirements of *prima facie* obviousness:

> First, there must be some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify the reference or to combine reference teachings. Second, there must be a reasonable expectation of success. Finally, the prior art reference (or references when combined) must teach or suggest all the claim limitations. The teaching or suggestion to make the claimed combination and the reasonable expectation of success must both be found in the prior art, not in applicant's disclosure.

In general, the primary reference, Yang et al., describes exposing a specific dielectric films (i.e., nanoporous silica) to an electron beam after an optional hydrophobic treatment by an organic reactant (See, Yang et al. at the Abstract).

In general, Yoshioka et al. describe methods for developing resist coatings in photolithography that provide the ability to accurately control line width of a resist pattern, to control line width on a real time basis, and to improve yield and throughput (See, Yoshioka et al. at col.1, lines 10-12 and 54-61).

Boas et al. specifically describe controlling the rate of heat transfer between a substrate and a thermal reservoir. Boas et al. specifically describe controlling such rate of heat transfer by "changing the thermal conductivity between the substrate and thermal reservoir, by changing the emissivity of a surface of the thermal reservoir, or by changing the distance between the substrate and the thermal reservoir" (See, Boas et al. at the Abstract).

Claims 1-13, 24, 25-36, and 37

As described at, e.g., lines 10-21 of page 5 of Applicants' specification as originally filed, one feature of the present invention helps to provide high quality dielectric films by integrating both curing and post-cure, in situ cooling into the same process station. This integration of curing

and cooling into the same process station virtually eliminates any kind of variation, including time variation, in the curing and cooling process. This is quite advantageous given that the curing step of dielectric film formation tends to be the most important step in the process. The integration of curing and cooling into a single process station also allows oxygen exposure to be accurately controlled at all times when the low-k spin on dielectric film is hot enough to be susceptible to thermal oxidation damage. In contrast to circumstances when a robot handles a very hot device bearing a dielectric film, in situ cooling also minimizes the robot's signature imparted to the cooled device when the device is removed from the station by the robot.

The inventive aspect of integrating the both curing and post-cure, in situ cooling into the same process station is recited in independent method claims 1, 24, 25, and 37. For example, this particular inventive aspect is recited in claim 1 as follows:

> [W]hile the coated substrate is positioned in the process chamber: (i)thermally curing the dielectric precursor to form the cured dielectric composition; and (ii)causing a gas to coolingly contact the cured dielectric composition ....

The primary reference, Yang et al., does not describe, e.g., Applicants' inventive aspect of integrating the both curing and post-cure, in situ cooling into the same process station. In fact, the Yang reference does not even describe a cooling step as used in the present invention. Because such a cooling step does not exist in the Yang reference, the Yang reference cannot provide any suggestion or motivation to combine curing and post-cure, in situ cooling steps into the same process station.

The secondary references, Yoshioka et al. and Boas et al., fail to overcome such deficiency of the Yang reference. That is, neither the Yoshioka reference nor the Boas reference teach or suggest Applicants' inventive aspect of integrating both the curing and post-cure, in situ cooling into the same process station.

While the Yoshioka reference generally describes a cooling step (See, Yoshioka et al. at col. 2, line 6), the Yoshioka reference specifically describes a pre-baking unit, post-baking unit, cooling unit, and an extension-cooling unit as separate "units," where a wafer is transferred into and out of each unit by a "main arm mechanism 22" for processing in each respective unit (See, Yoshioka et al. at Figure 3, col. 6, lines 3-29, col. 7, lines 32-40, col. 8, lines 29-56). More importantly, the Yoshioka reference does not teach or even suggest combining both the curing and post-cure, in situ cooling into the same process

station. In other words, the Yoshioka reference does not overcome the deficiency of the Yang reference.

As mentioned, the Boas et al. reference specifically relates to controlling the rate of heat transfer between a substrate and a thermal reservoir. While the Boas reference does describe heating up and cooling down a substrate in a thermal process chamber (See, the Boas reference at col. 4, lines 10-43), it does not specifically describe, e.g., both the curing and post-cure, in situ cooling into the same process station as used and described in Applicants' specification. That is, more specifically, the Boas reference does not describe, e.g., "A method of forming a cured, dielectric composition on a substrate, comprising the steps of: (a) coating ... the substrate; (b) causing the coated substrate to be positioned in a process chamber; (c) while the coated substrate is positioned in the process chamber: (i) thermally curing the dielectric precursor ... ; and (ii) causing a gas to coolingly contact the cured dielectric composition; and ...." as recited in Applicants' claim 1. Thus, the Boas reference does not overcome the deficiency of the Yang reference.

In short, the combination of the Yoshioka and the Boas references does not teach or suggest to modify the Yang reference to integrate both the curing and post-cure, in situ cooling into the same process station.

Therefore, because the Yang reference does not teach or suggest, e.g., integrating both the curing and post-cure, in situ cooling into the same process station and neither the Yoshioka nor the Boas reference, alone or in combination, fail to overcome such deficiency, a *prima facie* case of obviousness has not been established with respect to independent method claims 1, 24, 25, and 37. Likewise, a *prima facie* case of obviousness has not been established for claims 2-13, each dependant on claim 1, and claims 26-36, each dependant claim 25.

Claims 14-22

As described at, e.g., lines 27-30 of page 4 of Applicants' specification as originally filed, another feature of the present invention includes controlling the time periods between one or more of coating, baking, curing, and/or cooling steps can greatly enhance the throughput, uniformity, and quality of low-k dielectric films.

This inventive aspect is recited in independent method claim 14.

The primary reference, Yang et al., does not teach or even suggest, e.g., Applicants' inventive aspect of controlling the time periods between one or more of coating, baking,

curing, and/or cooling steps. Both of the secondary references, Yoshioka et al. and Boas et al., alone or in combination, fail to overcome such deficiency of the Yang reference.

Therefore, because the Yang reference does not teach or suggest, e.g., controlling the time periods between one or more of coating, baking, curing, and/or cooling steps as described in Applicants' specification and neither the Yoshioka nor the Boas reference, alone or in combination, fail to overcome such deficiency, a *prima facie* case of obviousness has not been established with respect to independent method claim 14. Likewise, a *prima facie* case of obviousness has not been established for claims 15-22, each dependant on claim 14.

Claim 23

As described at, e.g., line 23 of page 7 to line 2 of page 8 of Applicants' specification as originally filed, another feature of the present invention includes a method of forming a cured, dielectric composition on a substrate. A composition comprising a thermally curable, dielectric precursor and an amount of solvent such that the composition has a coatable viscosity is coated onto at least a portion of the substrate. The coated substrate is pre-baked at a first, relatively low temperature profile under conditions such that at least a portion of the coated dielectric precursor is uncured and the coated composition comprises a residual amount of solvent. The dielectric precursor is thermally cured at a second, relatively high temperature profile under conditions such that at least substantially all of the dielectric precursor is cured to form the dielectric composition. The cured dielectric composition is then cooled.

This inventive aspect is recited in independent method claim 23.

The primary reference, Yang et al., does not teach or even suggest at least one of Applicants' inventive aspects, such as, e.g., pre-baking the coated substrate at a first, relatively low temperature profile under conditions such that at least a portion of the coated dielectric precursor is uncured and the <u>coated composition comprises a residual amount of solvent</u>. Both of the secondary references, Yoshioka et al. and Boas et al., alone or in combination, fail to overcome such deficiency of the Yang reference.

Therefore, because the Yang reference does not teach or suggest, e.g., pre-baking the coated substrate at a first, relatively low temperature profile under conditions such that

at least a portion of the coated dielectric precursor is uncured and the coated composition comprises a residual amount of solvent, as described in Applicants' specification, and neither the Yoshioka nor the Boas reference, alone or in combination, fail to overcome such deficiency, a *prima facie* case of obviousness has not been established with respect to independent method claim 23.

Based on the foregoing statements, Applicants request that the rejection of claims 1-37 under 35 USC 103(a) as being unpatentable over Yang et al. in combination with Yoshioka et al. and further in combination with Boas et al. be withdrawn.

Applicants repeat the request that the rejection of claims 1-37 under 35 U.S.C. 103(a) as being obvious be withdrawn. As further support for this request, Applicants consider 37 C.F.R. 1.104(c)(2), which states:

> In rejecting claims for want of novelty or for obviousness, the examiner must cite the best references at his or her command. When a reference is complex or shows or describes inventions other than that claimed by the applicant, <u>the particular part relied on must be designated as nearly as practicable</u>. The <u>pertinence</u> of each reference, if not apparent, <u>must be clearly explained</u> and each rejected claim specified (Emphasis added).

As is evident from the discussion above, the cited references describe complex inventions. The primary reference Yang et al. describe exposing a specific dielectric films (i.e., nanoporous silica) to an electron beam after an optional hydrophobic treatment by an organic reactant. Yoshioka et al. describe methods to accurately control line width of a resist pattern, to control line width on a real time basis, and to improve yield and throughput. And Boas et al. specifically describe controlling the rate of heat transfer between a substrate and a thermal reservoir.

As mentioned above, the Office Action merely cites the Yang, Yoshioka, and Boas references, followed by a conclusion of obviousness. It is not apparent from the present Office Action, how or where the cited Yang et al. reference renders obvious, alone or in combination with the Yoshioka et al. and Boas et al. references, the following exemplary features of Applicants' rejected claims:

- Steps (a)-(d) as recited in claim1;
- "anaerobic conditions" as recited in claims 2, 3, 7, 19, 20, 21, and 24;

- "anaerobic environment" as recited in claim 5-6;
- Steps (a)-(e) as recited in claim 14;
- the "time intervals" as recited in claims 15-17;
- steps (a)-(d) as recited in claim 23;
- steps (a)-(d) as recited in claim 24;
- steps (a)-(d) as recited in claim 25; and
- steps (a)-(c) as recited in claim37.

Because the pertinence of the cited references is not apparent from the Office Action and the particular part of each reference relied on by the Office Action is not clearly explained in the Office Action, the rejection of claims 1-37 as obvious over the cited references is improper.

Accordingly, Applicants again respectfully request that the outstanding rejection of claims 1-37 under 35 USC 103(a) as being unpatentable over Yang et al. in combination with Yoshioka et al. and further in combination with Boas et al. be withdrawn.

CONCLUSION

In view of the above remarks, it is respectfully submitted that the claims and the present application are now in condition for allowance. Approval of the application and allowance of the claims is earnestly solicited. In the event that a phone conference between the Examiner and the Applicant's undersigned attorney would help resolve any remaining issues in the application, the Examiner is invited to contact said attorney at (651) 275-9804.

Respectfully Submitted,

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